

In more detail, in one embodiment, there is provided a plurality of individually controlled miniature motors oriented in a grid, each of which responds to a portion of the processed electrical signals. A plurality of miniature rack and pinion gear assemblies are also provided, each of which is operatively connected to one of the miniature motors so that rotational motion of a pinion connected to a shaft of a miniature motor is converted into linear motion of a rack. A plurality of rods form the surface of the tactile display, each of which is connected to one of the racks, so that when the racks move linearly, the rods move linearly as well. The relative linear motion of the individual rods forms a "tactile image." The motors could be formed by micro or nano-motors to produce very high resolution tactile images.

Means for adapting the tactile display means to a portion of the body of a visually impaired person may also be provided, and would include means for causing the rods to move perpendicular to the surface of the portion of the body. For example, the tactile display could be a two-dimensional grid in the shape of a hand or finger tip, for example. It does not necessarily have to be rectangular, for example.

For specialized applications, the display could be made spherical and about the size of a tennis ball, for instance. When held in the hand, and provided with 3-D information about an apple, for example, the sphere would take the three-dimensional form of the apple. In this embodiment, the rods would be extendable and retractable from a spherical initial position. In this embodiment, multiple imaging means, e.g., three cameras located in a triangulation arrangement, would be used, to obtain the three dimensional front, back and side information.

Thus, a tactile image is formed by the movement of the rods against the body (skin) of the person.

In a further embodiment according to the invention, as shown in FIG. 5, an auxiliary display means may be provided for indicating the color of the object, through a particular mechanical vibration for a particular color, for example. The output means and filtering means cause the tactile display through the auxiliary display means to also provide an indication of color. This could be used to indicate a red or green light signal, for example, or flashing yellow lights, which would be otherwise imperceptible to a vision impaired person.

FIG. 6 is a block diagram of an exemplary embodiment of an apparatus for converting sounds into tactile representations for use by a person who is hearing impaired, including auditory means, according to the invention. Similarly to the image processing described above, sounds would be detected and processed to form a tactile image. If the processing includes speech analysis, for example, the tactile display could be caused to form alphabetical or braille type characters.

If used in conjunction with the imaging features, the auditory processing could indicate a general noise level, such as are used by non-sighted persons to detect traffic patterns, machinery, etc. A specific portion of the tactile display could be dedicated to imaging while another portion would be dedicated to auditory display. Alternatively, separate displays could be provided for each function.

It will be apparent to one of ordinary skill in the art that the manner of making and using the claimed invention has been adequately disclosed in the above-written description of the preferred embodiment taken together with the drawings.

It will be understood that the above description of the preferred embodiment of the present invention is susceptible

to various modifications, changes, and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

For example, instead of video cameras, sonar or radar, or a combination of the three could be used for imaging objects in the field of view in question.

Besides displaying tactile images through the movement of mechanical rods, heat or vibration could be used, alone or in combination to indicate objects.

If a larger degree of processing power is provided, image identification along with a synthesized voice output could be used. For example, if the device could recognize a familiar object or person, the voice synthesizer could issue a spoken alert such as "mailbox" or "Mr. Bill" to the user.

Another application of the device could be as a hand-held text to braille reader. The imaging portion would be scanned over a printed document and the processing means would cause braille representations of the scanned text to be produced on the tactile display for sensing by the user.

If the imaging means is replaced or augmented with a listening device, i.e., a microphone, and the processing means includes speech analysis operations, the tactile display could be caused to output braille characters, or another representation, corresponding to detected speech. The device could be adapted to connect to a telephone so that tactile representations of speech received through the telephone are produced.

The device could also have applications for users who are not visually impaired but find themselves in conditions where visibility is limited. Sonar and/or radar imaging could here be used to "see" through fog and alert the person to object ahead through a tactile representation on the tactile display.

The invention thus covers a wide range of applications where transforming from the visual and/or auditory to the tactile has use. With advances in micro and nano-motor technology, tactile displays of extremely high sensitivity can be provided.

The device was initially envisioned as being used by sensory-limited individuals, however, other uses are considered to be within the scope of the invention.

What is claimed is:

1. An apparatus for converting visual images into tactile representations for use by a person who is visually impaired comprising:

imaging means for converting incident light into electrical signals;

processing means for processing the electrical signals; and

tactile display means for converting processed electrical signals into tactile images;

whereby the tactile images are felt by the visually impaired person enabling them to ascertain information by touch about the world around them that a sighted person would ascertain through vision;

wherein the tactile display means comprises:

a plurality of individually controlled miniature motors oriented in a grid each of which respond to a portion of the processed electrical signals;

a plurality of miniature rack and pinion gear assemblies, each of which is operatively connected to one of the miniature motors so that rotational motion of a pinion connected to a shaft of a miniature motor is converted into linear motion of a rack;

a plurality of rods, each of which is connected to one of the racks, so that when the racks move linearly, the rods move linearly as well;